

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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In the application of:

Mukerrem Cakmak et al.

Serial No: 10/692,584

Filed: October 24, 2003

For: **PROCESS FOR MAKING  
STRAIN-HARDENED POLYMER  
PRODUCTS**

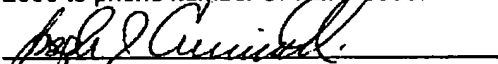
) Group Art Unit: 1713

) Confirmation No: 9481

) Examiner: Rip A. Lee

) **CERTIFICATE OF FACSIMILE  
TRANSMISSION**

) I hereby certify that this correspondence was  
) transmitted to the United States Patent and  
) Trademark Office via facsimile on February 14,  
) 2006 to phone number 571-273-8300.

)   
) Joseph J. Crimaldi

**DECLARATION OF MUKERREM CAKMAK  
UNDER 37 C.F.R. §1.132**

Mail Stop RCE  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

I, Mukerrem Cakmak, declare and say as follows:

(1) I have received the following degree(s): a Bachelor of Science Degree in Chemical Engineering from The Technical University of Istanbul in 1975; a Master of Science Degree in Polymer Engineering from the University of Tennessee, Knoxville in 1979; and a Ph.D. in Polymer Engineering from the University of Tennessee, Knoxville in 1984.

(2) I have been working in the field of polymer engineering for at least 30 years and currently hold the position of Professor of Polymer Engineering at The University of Akron (Main Campus in Akron, Ohio).

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(3) I am one of the co-inventors for United States Patent Application No. 10/692,584 (hereinafter USSN 10/692,584).

(4) I have been asked to comment on the nature of the disclosure contained in U.S. Patent No. 6,407,155 (hereinafter Qian et al.) currently of record in USSN 10/692,584 and on what a person skilled in the art would have understood by the disclosure contained in Qian et al.

(5) I have read Qian et al. and will comment on Qian et al. as it relates to the strain hardening of polymers. I have also been asked to comment specifically on the nature of the disclosure contained in Qian et al. as it relates to Figure 1 contained therein.

(6) First of all, absent specific evidence to the contrary, the data contained in Qian et al. must have been obtained at room temperature. This is because it is common practice to conduct mechanical "strain" testing at room temperature. Since Qian et al. does not specifically state that the testing conducted therein was done at a temperature other than room temperature, one of ordinary skill in the art would be led to believe, and could only conclude, that all testing discussed in Qian et al. was conducted at room temperature.

Furthermore, the data of Figure 1 of Qian et al. is presented as "load versus displacement". As would be apparent to one of ordinary skill in the art, this means the machine that is used to stretch the sample(s) has a force transducer that records the force and gauge separation in the machine. It is this information that is used to generate the "displacement" data of Figure 1. As would be apparent to one of ordinary skill in the art, this is not even proper mechanical testing. There are several variants of how the data should be interpreted/analyzed:

a) At a minimum an engineering measurement would take the initial cross-sectional area prior to conducting the above-mentioned test. This information, the initial cross-sectional area, would be used as the divisor to divide all of the load measurements to obtain what is called "engineering stress". In addition the engineering strain can also be calculated using the initial length of a sample and the time variation of

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the sample length as calculated using displacement. This yields the following engineering strain measurement equation:

$$\text{Engineering Strain} = (\text{Length at a Given Time} - \text{Initial Length}) / \text{Initial Length}.$$

The above equation is accepted throughout the polymer industry. But from the point of view of actual material response to deformation the above equation does not represent the true mechanical behavior of a material as the time variations of a load (or forces) are not divided by the continuously varying cross-sectional area to obtain the true stress. As indicated above, all time varying force values are divided by initial un-deformed sample cross-sectional area.

b) Aside from the poor presentation of the data (load versus displacement), if one of ordinary skill in the art would look at the description contained in the specification of Qian et al. as it relates to Figure 1, one would recognize that there is not much information disclosed as to how those samples were/are prepared for testing. Qian et al. states at column 24, line 43 through column 25, line 26 that Example 8 and Comparative Example 4, the Examples used to generate the specimens tested in Figure 1, were prepared by injection molding. As would be apparent to one of ordinary skill in the art, test samples produced by injection molding "behave" differently from those produced by extrusion, film casting, or by compression molding.

(7) Additionally, since the testing of the samples conducted in Qian et al. is done at room temperature, one of ordinary skill in the art would recognize that a wide range of polymer compositions/composites strain harden at room temperature. However, very few polymer compositions and/or composites are able to undergo strain hardening at elevated processing temperatures. As detailed in the present application, the strain hardening data of the present invention is collected at 75, 85 and 95°C for poly(lactic acid) (PLA) and at 105, 115 and 125°C for polystyrene (PS) where they are in a rubbery state.

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(8) The data contained in our patent application presents what is called "true stress – true strain measures". In our case, we take the time varying forces and divide each force value by its corresponding cross-sectional area so that we continuously correct for the changes of the dimensions of the sample as it thins down. Since we are measuring the instantaneous cross-section of the samples we also measure " true strains". If a sample undergoes strain hardening, a region of the sample (*i.e.*, the cross-sectional area being measured) will stop deforming and this fact is immediately noticeable by the sensors of the machine conducting the measurements detailed in the present patent application. This in turn yields a very clear sudden upturn in the true stress-true strain curves. Therefore using the measurement technique described in our patent there is no doubt when the strain hardening occurs.

(9) In view of the above, the disclosure contained in Qian et al., and the disclosure made in our current patent application, the following points can be made:

a) Qian et al. (*i.e.*, Figure 1) only reports load versus displacement data. This data is totally unrepresentative of the instantaneous cross-sectional area and strain hardening. Qian et al. does not even bother to report the exact "supposed" true strain values. Thus, the data contained in Qian et al. simply indicates the displacement of the machine crosshead.

b) As would be apparent to one of ordinary skill in the art, upon reading and understanding Qian et al., the data contained therein are engineering measurements that do not truly represent the correct mechanical behavior of the polymers disclosed therein. Accordingly, an accurate determination of whether or not strain hardening occurred in the polymer compositions of Qian et al. is not possible from the data presented therein.

c) True measures of stress/strain behavior correctly represent the mechanical behavior of a polymer material. In our patent application we use a method that yields such data, as opposed to the method utilized in Qian et al.

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d) The true stress – true strain measurements conducted in the present patent application were conducted at elevated temperatures (*i.e.*, at 75, 85 and 95°C for poly(lactic acid) (PLA), and at 105, 115 and 125°C for polystyrene (PS)).

(10) Furthermore, in the present patent application the true stress – true strain measurements were conducted on polymer samples where crystallization has not occurred prior to the application of a deformation force. As would be apparent to one of ordinary skill in the art, if crystallization takes place prior to the application of a deformation force by, for example, a thermal crystallization mechanism that causes large crystals to grow in the polymer prior to the film stretching process, the ensuing stretching process will not work correctly as the already existing crystallites will start breaking and the polymer material will show yielding followed by breakage.

(11) One aspect of the present invention is that via the judicious use of nanoparticles, the present invention enables the realization of the strain hardening mechanism in a polymer during rubbery state stretching. That is, the realization of the strain hardening mechanism in a polymer stretched at elevated temperatures not at room temperature in the absence of or with very little, less than about 10%, crystallinity in the polymer phase. Since polymers generally exhibit a behavior similar to a rubber band during deformation, under the conditions of the present invention when the strain hardening takes place the mechanism will stop the deformation of the polymer material in the areas that are strain hardened. This in turn permits other parts of the polymer films to stretch thereby allowing “self leveling” to occur. This leads to an improvement in the thickness uniformity in the film at the end of the deformation process.

Another advantage of the present invention is that it permits the strain hardening of a polymer film via the inclusion of small amounts of nanoparticles. This can be important in a wide variety of applications, including where a transparent film is desired (*e.g.*, packaging applications).

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(12) In view of the disclosure contained in Qian et al., one of ordinary skill in the art would not have arrive at the process of the present invention, as recited in pending claims 11 through 19. Accordingly, Qian et al. fails to disclose, teach or suggest a process for controlling the strain hardening of a polymer as recited in pending claims 11 through 19 of the present patent application. Additionally, Qian et al. fails to disclose, teach or suggest polymer products produced by such a method.

(13) I, Mukerrem Cakmak, declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: 2/14/06

M. Cakmak  
Mukerrem Cakmak

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